REMARKS/ARGUMENTS

In response to the pending Office Action of December 6, 2006, Applicants present the following arguments and amendments. The present amendments are requested solely for the purpose of more clearly describing and claiming the present invention and do not introduce any new matter. Applicant submits that in light of the arguments presented and amendments requested, this application is in condition for allowance. Accordingly, entry of these amendments, reconsideration of all pending rejections and objections, and passage to allowance is respectfully requested. With the entry of this amendment, claims 1-3, 5-26 and 28-36 are pending herein.

Amendments to the claims

Amendments of claim 1 is requested to recite "wherein the silicon nanofilm is not greater than about 200 nm thick." Support for the requested amendment to this claim is provided by claim 4 as originally presented which provides "the silicon nanofilm is not greater than about 200 nm thick" and by the description in paragraph [0044]. The requested amendment to claim 1 is provided to enhance clarity and particularly point our and distinctly claim certain aspects of the present invention. Amendment of claim 1 does not introduce any new matter.

Amendment of claims 3 and 10 is request to eliminate recitation of the term "about" in these claims. The requested amendments to these claims do not introduce any new matter.

Amendment of claim 5 is requested to make the dependency of this claim consistent with the requested amendment of claim 1 and cancellation of claim 4. The requested amendment is provided to enhance clarity and does not introduce any new matter.

Amendment of claim 9 is requested to improve antecedent basis by changing the recitation "nanofilm" to recite "nanoparticle" as referenced in claim 8 from which claim 9 depends. The requested amendment is provided to enhance clarity and does not introduce any new matter.

Amendment of claim 29 is requested to more particularly point out and distinctly claim the present invention. Support for this amendment is provided throughput the specification, for example in paragraph [0016]. The requested amendment to claim 29 does not introduce any new matter.

New claim 36 is added to more particularly point out and distinctly claim the present invention. Support for new claim 36 is provided by Figures 6a and 6b and the related description in paragraph [0065] and which exemplify nanostructure silicon films of the present invention comprising "a contiguous film" unbroken by grain boundaries, dislocations, or cracks. New claim 36 does not introduce any new matter.

Rejections under 35 U.S.C. § 112

Claims 3 and 10 are rejected under 35 U.S.C. § 112, second paragraph, as being "indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention." In support of this rejection the examiner concludes "[t]he term 'about' is a relative term which renders the claim indefinite."

Applicants disagree with the Examiner characterization of claims 3 and 10. To expedite prosecution and without acquiescing to the rejections, however, the term "about" has been removed from the rejected claims. Accordingly, reconsideration and withdrawal of all the present rejections under 35 U.S.C. § 112, first paragraph, is requested.

Claim 6 is rejected under 35 U.S.C. § 112, second paragraph, as being "indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention." In support of this rejection the examiner concludes "[t]he term 'substantially' is a relative term which renders the claim indefinite" and asserts that '[t]he term 'substantially' is not defined by the claim, [and] the specification does not provide a standard for ascertaining the requisite degree."

Applicants disagree with the Examiner characterization of claim 6 as indefinite because an electron diffraction pattern is provided in Figure 6A (see inset) that provides adequate characterization of a "substantially amorphous" silicon nanofilm of the present invention (See also, related description of Figure 6A in paragraph [0065]). Applicants assert that in light of this teaching and the generally well understood meaning of this term, one of ordinary skill in the art would be reasonably able to discern from the specification in its entirety and by specific reference to the electron diffraction pattern in Figure 6A that the that the term "substantially amorphous" as used herein clearly refers to thin film compositions other than purely crystalline phases. Accordingly, Applicants respectfully request reconsideration and withdraw of the present rejection under 35 U.S.C. § 112, first paragraph.

Rejections under 35 U.S.C. § 102

Claims 1 and 3-6 are rejected under Section 102(b) as allegedly anticipated by Sayama *et al.* (New Active Material Structure in Si Thin Film Electrode for Rechargeable Lithium Batteries, Abstract 52, The 11th Meeting on Lithium Batteries, Monterey CA, June 23-28, 2002 (hereafter "Sayama")). In support of these rejections, the Examiner characterizes Sayama as disclosing:

> An electrode for rechargeable lithium batteries comprising a silicon nanofilm. Silicon thin films were deposited by a plasma CVD or an RF magnetron sputtering method on the current collector of electrolytic copper foil. The thickness was between 2 and 10 μm and is amorphous.

Applicants respectfully disagree with the present rejections under Section 102(b), and request reconsideration and withdrawal of the rejections in light of the following arguments.

Silicon nanofilms and lithium alloys thereof of the present invention include specifically engineered structural attributes giving rise to electronic and mechanical properties beneficial for their use as electrodes in secondary electrochemical cells. For example, silicon nanofilms exhibiting particularly useful properties have a nanoscale thickness physical dimension that minimizes or entirely eliminate the formation of cracks and dislocation during lithium insertion and de-insertion reactions and that is capable of accommodating very high cycling rates. As a result of this specific structural attribute, for example, silicon nanofilm electrodes of the present invention enable an innovative class of high performance secondary electrochemical cells exhibiting large cycle lifetimes and specific capacities for a range of useful discharge conditions (See, e.g., Example 7, paragraphs, [0070] – [0073]). To emphasis this important aspect of the electrodes of the present invention, claim 1 has been amended to recite the limitation that "the silicon nanofilm is not greater than about 200 nm thick."

Although Sayama reports secondary electrochemical cells capable of providing specific capacities as large as 3990 m A h/g, the silicon film structures employed in this reference differ in fundamental ways from the nanostructured silicon thin films of the present invention. Specifically, the disclosure in Sayama is limited to electrode configurations consisting of silicon films having thicknesses ranging from 2 microns to 10 microns (See, Sayama paragraph 3, Figure 1 and Figure 2). In contrast to the micro-sized silicon films of Sayama, silicon nanofilms of electrodes of the reject claims are nanostructured materials having thicknesses that are not greater than about 200 nm thick. As the silicon thin films of the present invention have a thickness dimension that is ***at least one order of magnitude less*** than the silicon films disclosed in Sayama, this reference does not anticipate rejected claims 1 and 3-6.

The distinction between the nanostructured silicon nanofilms of the present invention and the micro-sized films of Sayama is highly material to the electronic properties of secondary electrochemical cells having electrodes comprising these materials. First, silicon nanofilms of the present invention having submicron thicknesses accommodate very high cycling rates as demonstrated in Example 7, paragraphs [0070] – [0073], (See, also , Fig. 11A). Applicants directly attribute this important performance benefit of the present invention to the "short diffusion lengths involved in the alloying process" accessed using silicon films having submicron thicknesses. Second, the present silicon nanofilms have submicron thicknesses that provide secondary electrochemical cells exhibiting high, reversible cycle lives, even under very large discharge rates. This important performance benefit is demonstrated by Figs. 11a and 11b and the related discussion in paragraph [0073] showing that "there is no irreversible capacity associated with increasing the cycling rate by three orders of magnitude" for the present silicon nanofilms. As described in detail in Example 8, paragraphs [0080] – [0082], applicants directly attribute the observed enhancements in cycling performance to the incorporation of silicon nanofilms having thicknesses much smaller (i.e., at least one order of magnitude) than the bulk silicon films disclosed in Sayama. Specifically, Applicants assert that use of nanostructured silicon films results in "the absence of convention mechanisms for microstructural damage" upon cycling. In support of this assertion, Applicants note that to the best knowledge of the Applicants "[d]islocations have never been reported in crystals of the disclosed dimensions." Further, Applicants provide a detailed theoretical analysis of crack propagation in the specification showing that a critical flaw size of 300 nm is required for crack propagation, "which is similar to or larger than the dimensions of the disclosed nanostructured electrode materials." (See, paragraphs [0080] – [0081]). Accordingly, use of silicon nanofilms having a thickness physical dimension less than this critical flaw size is believed to effectively suppress crack formation upon cycling consistent with the

observed cycling enhancements in secondary electrochemical cells incorporating the claimed electrode materials.

As amended with this response, the nanosized thickness dimension of the present silicon nanofilms entirely distinguishes the claimed electrodes from those described in Sayama. Moreover, experimental observations and analysis provided in the specification clearly demonstrate the significance of this distinguishing structural attribute in connection with important performance enhancements observed upon incorporation of these materials into secondary electrochemical cells. Since Sayama does not disclose, teach or even suggest an electrode configuration having a silicon nanofilm not greater than about 200 nm thick, it does not anticipate claims 1 and 3-6. Accordingly, reconsideration and withdrawal of the Examiner's rejections are respectfully requested.

Claims 8-11 are rejected under Section 102(b) as allegedly anticipated by Li et al. (The crystal Structural Evolution of Nano-Si anode Caused by Lithium Insertion and Extraction at Room Temperature, Solid State Ionic, 135 (2000) 181-191 (hereafter "Li")). In support of these rejections, the Examiner characterizes Li as disclosing:

> Li discloses an electrode comprising a silicon nanoparticle. The diameter of the nanoparticle is 80 μm (See Experimental). Li discloses that the insertion of lithium ions at room temperature destroys the crystal structure of Si gradually and leads to the formation of metastable amorphous Li-Si alloy.

Applicants respectfully disagree with the present rejections under Section 102(b) and request reconsideration and withdrawal of the rejections in light of the following arguments.

Applicants agree with the Examiner's assertion that Li discloses an electrode comprising silicon nanoparticles. Li further characterizes this electrode material,

however, by teaching that "the average size of the Si particles are **80 nm**, with a **20 nm distribution**." (See Li, 4th paragraph, 2nd sentence). Accordingly, nanoparticle electrode materials in Li are limited to a range of diameters from 60 nm to 100 nm. In contrast, the electrode material of the rejected claims comprises a silicon nanoparticle "wherein the diameter of the silicon nanoparticle is not greater than about **50 nm in diameter**". The present rejections under Section 102(b) are improper because Li does not disclose, teach or even suggest an electrode configuration comprising a silicon nanoparticle having a diameter less than about 50 nanometers. Accordingly, Applicants submit that Li does not anticipate claims 1 and 3-6, and reconsideration and withdrawal of the Examiner's rejections are respectfully requested.

Rejections under 35 U.S.C. § 102/103

Claims 2 and 7 are rejected under Section 102(b) as allegedly anticipated by, or in the alternative, under 35 U.S.C. 103(a) as obvious over Sayama. In support of these rejections, the Examiner asserts:

> Sayama does not expressly disclose that the silicon nanofilm alloys with lithium at ambient temperature (instant claim 2). However, the Examiner notes that it is an inherent property of when lithium ions are inserted into Si particles; [and]
>
> Sayama does not disclose that the silicon nanofilm is synthesized by physical vapor deposition (instant claim 7). Sayama discloses that the silicon nanofilm is synthesized by plasma CVD or an RF magnetron sputtering method (see Experimental). However, the courts have held that the method of forming the product is not germane to the issue of patentability of the product itself.

Applicants respectfully disagree with the present rejections under Section 102(b)/103 and request reconsideration and withdrawal of the rejections in light of the following arguments.

The arguments presented above relating to the deficiencies of Sayama are reasserted. Contrary to the Examiner's characterization, Applicants submit that Sayama does not disclose, enable or suggest all the limitations of the

rejected claims because this reference does not teach or suggest an electrode comprising a silicon nanofilm that "is not greater than about 200 nm thick." Claims 2 and 7 are not rendered obvious by the cited reference because Sayama fails to teach, enable or suggest all the limitations in the amended claims and the missing claim limitations are well outside the grasped of the typical artisan at the time of invention. *See, e.g.*, In re Royka, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). It is therefore submitted that no *prima facie* case of anticipation or obviousness has been made out with respect to these rejections under Sections 102(b)/103, and reconsideration and withdrawal thereof is respectfully requested.

Claim 12 is rejected under Section 102(b) as allegedly anticipated by, or in the alternative, under 35 U.S.C. 103(a) as obvious over Li. In support of these rejections, the Examiner asserts:

> Li does not disclose that the silicon nanoparticle is synthesized by inert gas condensation and ballistic consolidation. Li discloses that the nanoparticles are coated from a slurry onto a current collector (See Experimental). However, the courts have held that the method of forming the product is not germane to the issue of patentability of the product itself.

Applicants respectfully disagree with the present rejections under Section 102(b)/103 and request reconsideration and withdrawal of the rejections in light of the following arguments.

The arguments presented above relating to the deficiencies of Li are reasserted. Contrary to the Examiner's characterization, Applicants submit that Li does not disclose, enable or suggest all the limitations of the rejected claim because this reference does not teach or suggest an electrode comprising a silicon nanoparticle "wherein the diameter of the silicon nanoparticle is not greater than about 50 nm in diameter." Claim 12 is not rendered obvious by the cited reference because Li fails to teach, enable or suggest all the limitations in

the amended claims and the missing claim limitations are well outside the grasped of the typical artisan at the time of invention. *See, e.g.*, In re Royka, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). It is therefore submitted that no *prima facie* case of anticipation or obviousness has been made out with respect to this rejection, and reconsideration and withdrawal thereof is respectfully requested.

Rejections under 35 U.S.C. § 103

Claims 26-28 are rejected under Section 103(a) as allegedly unpatentable over Sayama. With respect to these pending rejections, the Examiner asserts:

> Sayama discloses all the elements of claim 1. Sayama does not disclose a battery comprising an anode, a cathode and an electrolyte. However, Sayama discloses that the Si thin film electrode is for rechargeable lithium batteries. It would have been obvious to one of ordinary skill in the art at the time the invention was made to use Sayama's Si thin film electrode for rechargeable lithium batteries for the benefit of providing power to electronic devices.

Applicants respectfully disagree with the Examiner's characterization of Sayama, respectfully traverse this rejection, and request reconsideration and withdrawal thereof in light of the following arguments.

Sayama does not disclose all the elements of claim 1, as amended with the present response. The arguments presented above relating to the deficiencies of Sayama are reasserted. Contrary to the Examiner's characterization, Applicants submit that Sayama does not disclose, enable or suggest all the limitations of the rejected claims because this reference does not teach or suggest an electrode comprising a silicon nanofilm that "is not greater than about 200 nm thick." Claims 26-28 are not rendered obvious by the cited reference because Sayama fails to teach, enable or suggest all the limitations in the amended claims and the missing claim limitations are well outside the grasped of the typical artisan at the time of invention. *See, e.g.*, In re Royka, 490

F.2d 981, 180 USPQ 580 (CCPA 1974). It is therefore submitted that no *prima facie* case of obviousness has been made out with respect to these rejections under Sections 103, and reconsideration and withdrawal thereof is respectfully requested.

Claims 29-31 are rejected under Section 103(a) as allegedly unpatentable over Li. With respect to these pending rejections, the Examiner asserts:

> Li discloses all the elements of claim 8. Li does not disclose a battery comprising an anode, a cathode and an electrolyte. Li discloses of making a cell using an electrode, a counter electrode and an electrolyte (see experimental). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use Li's nano-Si anode in a rechargeable battery, in particularly a rechargeable lithium ion battery , for the benefit of providing power to electronic devices.

Applicants respectfully disagree with the Examiner's characterization of Li, respectfully traverse this rejection, and request reconsideration and withdrawal thereof in light of the following arguments.

Li does not disclose all the elements of claim 8, as amended with the present response. The arguments presented above relating to the deficiencies of Li are reasserted. Contrary to the Examiner's characterization, Applicants submit that Li does not disclose, enable or suggest all the limitations of the rejected claim because this reference does not teach or suggest an electrode comprising a silicon nanoparticle "wherein the diameter of the silicon nanoparticle is not greater than about 50 nm in diameter." Claims 29-31 are not rendered obvious by the cited reference because Li fails to teach, enable or suggest all the limitations in the amended claims and the missing claim limitations are well outside the grasped of the typical artisan at the time of invention. *See, e.g.*, In re Royka, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). It is therefore submitted that no *prima facie* case of obviousness has been made

out with respect to this rejection under Section 103, and reconsideration and withdrawal thereof is respectfully requested.

CONCLUSION

In view of the foregoing arguments, this case is considered to be in condition for allowance and passage to issuance is respectfully requested. If new issues of patentability are raised, the Examiner is invited to call and arrange for an opportunity to discuss these issues via phone interview.

It is believed that a two month extension of time and fee of $225.00 is required with this submission and payment of this fee is being made via the EFS-Web system. If this amount is incorrect or if problems are encountered using the EFS-Web system, please deduct or credit the appropriate fees for this submission along with any extension of time required from Deposit Account No. 07-1969.

Respectfully submitted,

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